The Evolution-Creation Controversy: Opinions of Ohio High School Biology Teachers[1]

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ABSTRACT. This study presents the results of a 19-item questionnaire distributed to all high school biology departments in the state of Ohio. The results indicated that Ohio high school biology teachers are far more likely to support the teaching of evolution, and far less likely to support the teaching of creationism than is the public at large. Most biology courses in the state include some evolutionary component. There is also reasonably strong sentiment against the teaching of creationism in the public schools. The amount and quality of that evolutionary teaching, however, are apparently well below the ideal. Teachers are not particularly sophisticated in their understanding of evolutionary theory; only a little over one-half of them feel that the theory itself is testable. Almost three-fourths of the teachers recognize, however, that creationism is not based on a solid scientific foundation. Approximately 10% of them have experienced pressure from pro-creationism forces either to remove evolution from the curriculum or to install a creation component. Pro-evolutionary forces are much less active. Teachers favoring religion and prayer in the public schools are significantly more likely to teach creationism in their biology courses than those opposed.

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INTRODUCTION

The issues of whether and how evolution should be taught in the public schools of this country will apparently not go away. Laws dictating the content of the science curriculum in this regard have been in existence from 1922 to the present (Larson 1985). Additionally, the public has very strong feelings about the teaching of evolution. Public opinion polls have consistently shown that the vast majority of people are sympathetic towards "creation science".[2] For example, sampling performed by groups as diverse as the Associated Press, the National Broadcasting Company, *Glamour* magazine, and the Institute for Creation Research has yielded similar results: between 74% and 86% of those questioned wanted creationism brought into the public school classroom. These polls further indicated that a significant portion (10-16%) of the respondents prefer that *only* the creation model be taught (Fuerst 1984).

A smaller number of surveys of university and college students have been performed. Bergman (1979) questioned students at Bowling Green State University, Bowling Green, Ohio. Ninety-four percent of the 442 undergraduate students (most of whom were in the final year of a teacher training program) favored introducing the creation model into the classroom. Of the 74 graduate students that were sampled (all of whom were taking courses in biology), 78% held the same opinion. Fuerst (1984) surveyed 2,387 students taking science courses at the Columbus campus of The Ohio State University, and found that 80% favored bringing the creation model into the public school classroom. Christensen and Cannon (1978) reported on a 38-year (1935-1973) longitudinal study of student views on creationism at Brigham Young University, Provo, Utah. They found that, whereas only 36% of the students questioned in 1935 agreed with the statement, "Man's creation did not involve biological evolution, 81% of those surveyed in 1973 agreed. Similarly, in 1935, 5% concurred with the statement, "The world's creation did not take millions of years"; 27% concurred in 1973. They concluded that acceptance of creationism has been growing among university-age students during this period. Finally, Zimmerman (1986) surveyed 362 students at Oberlin College, Oberlin, Ohio and found that 56% of the respondents favored the introduction of creationism into the public schools. That such a large percentage of Oberlin College students held this view is particularly interesting in light of the fact that Oberlin College undergraduates consider themselves to be more liberal than do students at comparable colleges and universities (Zimmerman 1986). All of these results indicate that there is very broad support for the introduction of "creation science" into the public schools. Whether the public considers "creation science" to have a place in the science curriculum or in some other area of study has yet to be determined, however, as all previous questionnaires have failed to address this question explicitly.

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[2]Creation science has best been defined by Arkansas Act 590 of 1981: "Balanced Treatment for Creation-Science and Evolution-Science Act." 'Creation-science' means the scientific evidences for creation and inferences from those scientific evidences. Creation-science includes the scientific evidences and related inferences that indicate: (1) Sudden creation of the universe, energy, and life from nothing; (2) The insufficiency of mutation and natural selection in bringing about development of all living kinds from a single organism; (3) Changes only within fixed limits or originally created kinds of plants and animals; (4) Separate ancestry for man and apes; (5) Explanation of the earth's geology by catastrophism, including the occurrence of a worldwide flood; and (6) A relatively recent inception of the earth and living kinds." This definition itself is somewhat ironic since Judge W. R. Overton, in his opinion on the constitutionality of this law, found that there was no scientific evidence for "creation science." Creationism, as opposed to "creation science" does not shy away from biblical references (Morris 1974).

Clearly, the public's acceptance of "creation science" is very much at odds with the understanding of professional evolutionary biologists. The professional view, notwithstanding the ongoing debate concerning the specific mechanisms of evolutionary change, states that evolution is the foundation of all modern biology (Dobzhansky 1973). "Creation science" simply is not a valid alternative within the scientific community (Moore 1975, Lloyd 1981, Moyer 1981). Such a fundamental difference between the lay public and professionals can have serious implications for the type of instruction offered in public schools. Indeed, public school curricula are often influenced in part, if not in whole, by public opinion (Nelkin 1982). Bergman (1979), for example, concluded that since a majority of people favor the two-model approach, educators should move in the direction of implementing such a method of presentation. A pertinent question at this point is: On which side of this controversy do high school educators place themselves?

The present paper reports the results of a questionnaire distributed to every high school biology department in the state of Ohio. In particular, the questionnaire asked whether a section on evolution and/or creationism was included in the biology course offered. It also attempted to determine the respondents' thoughts about the scientific foundation of both evolution and "creation science," as well as their opinions on the inclusion of religion in public schools. Finally, the questionnaire asked teachers if they have ever felt pressure either to teach or not to teach evolution and/or "creation science." Because the questionnaire used a number of the same questions employed by Fuerst (1984) and Zimmerman (1986), a direct comparison among Ohio State University students, Oberlin College students, and Ohio high school biology teachers was possible.

METHODS

Three copies of a 19-item questionnaire (Appendix) were sent to the chairperson of the biology department of each of the 1,013 accredited high schools in Ohio on 1 February 1986. In addition to the questionnaires, a postage-paid, business reply envelope and a covering letter were included. The covering letter briefly explained the study, requested participation, and asked that the recipient distribute the questionnaires to all biology teachers in the school. Teachers offering two or more courses were requested to complete a questionnaire for each course. Complete anonymity was guaranteed. Therefore, no record of the geographic location of the respondents was kept, and no follow-up letter to either non-respondents or participants was possible.

The questionnaire asked each teacher to fill out the first four questions (i.e., those dealing with the course offered) separately for each course taught, and the remaining questions (i.e., those dealing with the instructor's opinions) just once. All responses from a single school were to be returned in the business reply envelope provided. Since all responses were received in the envelopes provided, it was easy to determine the number of schools responding, the number of individual teachers replying, and the number of biology courses offered by the respondents.

Nonparametric statistics (Siegel 1956) were used throughout the paper.

RESULTS

Responses were received from 296 (29.2%) of the 1,013 high schools contacted. These responses represented 404 individual instructors teaching 472 classes. The breakdown of respondents and courses into the various types of high schools are presented in Table 1.

TABLE 1

Number of respondents and courses representing the three types of high schools. Respondents either circling more than one answer or omitting the question are listed as unsure.

Type of school	No. of respondents	No. of courses
Public	329	391
Private sectarian	58	63
Private nonsectarian	10	11
Unsure	7	7
Total	404	472

EVOLUTION AND CREATIONISM IN THE CLASSROOM. The responses to question 2 indicated that 87.7% of the biology courses offered have some evolutionary component (Table 2). There was no significant difference in inclusion of an evolutionary component among the courses offered in public schools, private sectarian schools, and private nonsectarian schools (X^2-test, $P > 0.10$). Similarly, there was no significant difference in this respect between introductory biology courses and more advanced courses (e.g. Advanced Biology, Advanced Placement Biology, Genetics,) (X^2-test, $P > 0.80$). Table 2 also indicates that 21.8% of the courses have some creationism component. The type of institution in which the course is offered did have a significant effect (X^2-test, $P < 0.001$) on the inclusion of creationism, with public school courses being least likely to contain creationism. For the courses for which either a "yes" or "no" answer to question 3 was provided (i.e. omitting the courses ($N = 9$) for which teachers did not state whether creationism was included), 18.9% ($N = 322$) of those in public schools contained creationism. A much larger percentage of courses in private sectarian (39.7%, $N = 58$) and private nonsectarian (66.7%, $N = 9$) schools contained a section on creationism. As with question 2, there was no difference ($P > 0.90$) between introductory biology and advanced biology courses with respect to the inclusion of creationism.

It is possible that some of the teachers indicating that their biology course has a section on creationism actually present creationism in a negative light. For instance, one instructor responded: "I teach it (creationism) as superstition and poor theory." Written comments on the questionnaires were examined for the 102 classes that include a creationism component. Of those, 72 presented creationism favorably, six presented it negatively, and 24 did not provide enough information to make a determination. Thus, at least 15.25% (72 of 472) of the biology courses examined contained a creationism component that treated the topic favorably.

Of the courses containing evolution, the average number of class periods devoted to the subject was 7.5 (Table 3). There were no significant differences in the amount of time spent on the topic in the three types of schools (Kruskal-Wallis analysis of variance, $P > 0.50$). In biology courses with an evolutionary component, the number of class periods devoted to evolution was not independent of the inclusion of creationism. Courses containing creationism spent less time on evolution ($\bar{x} = 6.07$ periods, SD = 5.16, $N = 88$) than courses without creationism ($\bar{x} = 7.90$ periods, SD = 6.93, $N = 263$) (Mann-Whitney U-test, $z = 2.546$, $P < 0.011$). Only a small percentage (5.9) of the courses

TABLE 2

Percentage "yes" answers to questions 2, 3, 4a, 4b, 5–11, 15–17. Responses are grouped according to the type of school in which the instructor teaches.

Question	N	Type of school: Public	Priv/sect	Priv/nonsect	Unsure	Total
2. Is evolution taught in your course?	472	86.2	96.8	90.9	85.7	87.7
3. Is creationism taught in your course?	472	18.4	36.5	54.5	28.6	21.8
4A. Are you satisfied with evolution in text?	472	77.0	88.9	72.7	57.1	78.2
4B. Are you satisfied with creationism in text?	472	52.9	61.9	63.6	42.9	54.2
5. Has pressure been applied not to teach evolution?	404	12.2	1.7	0.0	0.0	10.1
6. Has pressure been applied to teach evolution?	404	5.8	3.4	0.0	0.0	5.2
7. Has pressure been applied to teach creationism?	404	12.2	5.2	10.0	0.0	10.9
8. Has pressure been applied not to teach creationism?	404	2.1	1.7	0.0	0.0	2.0
9. Is creationism religion in public schools?	404	54.7	34.5	60.0	28.6	51.5
10. Do you believe in theory of evolution?	404	80.9	65.5	80.0	57.1	78.2
11. Do scientists accept theory of evolution?	404	90.9	86.2	90.0	85.7	90.1
15. Should creationism be taught in public schools?	404	34.3	51.7	90.0	0.0	37.6
16. Do you object to religion in public schools?	404	65.3	32.8	60.0	0.0	59.4
17. Do you object to prayer in public schools?	404	41.3	19.0	40.0	0.0	37.4

TABLE 3

Number of class periods devoted to evolution and/or creationism by those teachers in Ohio who treat either topic.

Type of school	Evolution $\bar{x}$	SD	N	Low	High	Creationism $\bar{x}$	SD	N	Low	High
Public	7.5	6.68	286	0.5	50	2.2	2.09	52	0.25	10
Private sectarian	8.0	6.73	55	1	36	6.6	9.03	18	0.5	40
Private nonsectarian	5.7	3.19	10	2.5	10	2.9	2.78	6	0.5	7.5
Unsure	7.2	2.57	3	5	10	6.5		1		
Total	7.5	6.59	354			3.3	5.03	77		

(5.9) of the courses not having an evolutionary component incorporated a section on creationism (Table 4).

On average, 3.3 class periods were spent discussing creationism in courses that covered the subject (Table 3). Significant heterogeneity existed across the three types of schools, with courses in private sectarian institutions containing significantly (Kruskal-Wallis analysis of Variance, $P < 0.01$) more class periods on creationism than those in either of the other two types of schools. There were only three courses that contained creationism but not evolution, for which the instructor reported the amount of time spent on the topic. Each devoted one class period to the subject. Courses ($N = 74$) containing both evolution and creationism had a mean of 3.39 (SD = 5.11) class periods on creationism. However, because of small sample size, the number of class periods devoted to creationism in courses containing only creationism and in courses including a two-model approach did not differ significantly (Mann-Whitney U-test, $P > 0.30$). Virtually all (96.1%) of the courses containing a section on creationism also had a unit devoted to evolution (Table 4).

TABLE 4

Relationship between answers to questions 2 (Is there a section on evolution in your biology course?) and 3 (Is there a section on creationism in your biology course?) and responses to 14 other questions.

Percentage "yes" responses to:	Answer to question 2: Yes	No	Answer to question 3: Yes	No
Question 2			96.1	86.8
Question 3	23.9	5.9		
Question 4A	81.9	54.9	83.5	78.7
Question 4B	57.2	33.3	42.7	59.1
Question 5	10.6	7.3	10.9	10.2
Question 6	5.3	2.4	3.3	5.3
Question 7	11.2	7.3	9.8	10.9
Question 8	2.2	0.0	3.3	1.7
Question 9	52.7	39.0	20.7	61.4
Question 10	81.2	58.5	59.8	85.5
Question 11	92.4	73.2	82.6	93.4
Question 15	37.5	43.9	71.7	27.4
Question 16	60.8	51.2	44.6	64.0
Question 17	38.7	29.3	25.0	41.9

SATISFACTION WITH EVOLUTION AND CREATION COVERAGE IN TEXTBOOKS. A large majority (78.2%) of teachers voiced satisfaction with the coverage of evolution in their textbooks (Table 2). A much smaller majority (54.2%) expressed satisfaction with the coverage of creationism offered by their textbooks. Responses to both questions did not vary as a function of the type of school (X^2-tests: evolution, $P > 0.30$; creationism, $P > 0.20$). There was not a significant (X^2-tests: evolution, $P > 0.30$; creation, $P > 0.90$) relationship between teachers' satisfaction with the evolution component in their textbook, and the inclusion of either evolution or creationism in the class (Table 4). Significant relationships did exist, however, between the responses concerning the creationism sections in textbooks and course content (Table 4). People teaching evolution were slightly, but significantly (X^2-test, $P < 0.05$), more likely to

be satisfied with the coverage of creationism in their textbooks, whereas instructors omitting evolution were less likely to be satisfied with their textbooks' coverage of creationism. Conversely, people teaching creationism were significantly (X^2-test, $P < 0.001$) less likely to be satisfied with the way that creationism was presented in their textbooks. Of those teachers presenting evolution, there was no significant difference in number of class periods devoted to the subject between those satisfied and those unsatisfied with the coverage of evolution in their textbooks (Mann-Whitney U-test, $P > 0.08$; satisfied: $\bar{x} = 7.75$, SD = 6.83, $N = 296$; unsatisfied: $\bar{x} = 6.29$, SD = 5.31, $N = 49$). Similarly, of those teaching creationism, there was no difference in the number of class periods devoted to creationism by teachers satisfied and unsatisfied with the coverage in their textbooks (Mann-Whitney U-test, $P > 0.30$; satisfied: $\bar{x} = 3.96$, SD = 7.11, $N = 33$; unsatisfied: $\bar{x} = 2.86$, SD = 2.58, $N = 39$). Finally, teachers' feelings of satisfaction about evolution and creationism in textbooks did not appear to be independent of each other. Teachers satisfied (or unsatisfied) with one topic were significantly (X^2-test, $P < 0.001$) more likely to be satisfied (or unsatisfied) with the other than expected by chance alone.

The two questions concerned with teacher satisfaction with textbooks do not directly allow an analysis of why satisfaction or dissatisfaction was expressed. It is possible, for example, that some teachers could be unhappy with the evolutionary content because the books did not go into enough detail; others might feel that the coverage was too extensive. However, the comments offered by instructors often allowed such determinations to be made.

Results of the analysis of written comments are presented in Table 5. The results indicate appreciable homogeneity of opinion. Most people satisfied with the evolution component were pleased that it was covered in sufficient detail; most satisfied with the creationism coverage were content with its omission from the textbook. Similarly, most of the instructors dissatisfied with both evolution and creationism felt that neither was covered in sufficient depth.

PRESSURE TO ALTER CLASSROOM CONTENT. Approximately 10% of the respondents reported that they have been under some pressure not to teach evolution; 11% stated that they had received pressure to teach creationism (Table 2). Fewer teachers experienced pressure either to teach evolution (5%) or not to teach creationism (2%) (Table 2). Pressure against the teaching of evolution was not independent of type of institution; public school teachers received significantly (X^2-test, $P < 0.05$) more pressure than teachers in either type of private school. Pressure for and against creationism and pressure for the teaching of evolution were independent of school type (X^2-tests, $P > 0.05$).

The sources of pressure reported by respondents to questions 5-8 are listed in Table 6. The most frequent source of pressure cited was that by ministers and/or churches. Virtually all (95.8%) of the contacts from these sources took the form of recommending either that evolution be omitted or that creationism be included. Secondary in frequency of occurrence was pressure from members of school administrations and parents. Sixteen

TABLE 5

The frequency of impressions of those teachers offering written comments to questions 4A (Are you satisfied with your text's coverage of evolution?) and 4B (Are you satisfied with your text's coverage of creationism?)

	Satisfied with text		Dissatisfied with text	
Topic	Omitted	Adequately covered	Insufficient depth	Too much depth
Evolution	2	56	44	6
Creationism	88	7	77	1

of the 22 administration contacts were reported by teachers in public schools. Of these 16 public school contacts, eight pressured teachers not to teach evolution, three each pressured instructors to teach evolution and not creationism, and two encouraged the teaching of creationism.

Three people indicated that they perceived pressure to teach creationism and/or not to teach evolution, but stated that the pressure came either from God or from their own consciences. Similarly, one person claimed conscience as the reason for teaching evolution and not creationism. Such responses were coded as a lack of pressure.

Three teachers reported that they received pressure not to teach evolution, and that they did not currently include it in their courses. Each of these individuals believed in the modern theory of evolution (question 10). Of the 38 instructors that included evolution in their courses and received pressure not to do so, all but one stated that they subscribed to evolutionary theory. Only one person was pressured to teach evolution who is not currently doing so. That person indicated disbelief in evolution. Nine individuals that reported pressure to teach creationism currently include it in their courses. Of these nine, two teach in public schools; however they noted that they do not feel that creationism should be taught in public schools (question 15). Three instructors were pressured not to teach creationism and are currently doing so anyway. All three work in public schools and believe that creationism belongs in the public school curriculum.

CREATIONISM IN THE CLASSROOM: RELIGOUS INSTRUCTION OR NOT?. A majority (51.5%) of the re-

TABLE 6

Groups and individuals indicated as exerting the following type of pressure on teachers: pressure not to teach evolution (question 5); pressure to teach evolution (question 6); pressure to teach creationism (question 7); and pressure not to teach creationism (question 8). A number of respondents indicated that they received pressure from more than one source. Hence, the totals do not reflect the number of individual instructors receiving pressure.

Source of pressure	Question 5	Question 6	Question 7	Question 8	Total
Minister/Church	12	0	11	1	24
Administration	8	3	9	2	22
Parents	14	0	8	0	22
Students	5	1	13	0	19
Colleagues	4	3	2	5	14
Curriculum	0	11	1	0	12
Benefactor	0	0	1	0	1
Spouse	0	0	1	0	1
Textbook	0	1	0	0	1
Total	43	19	46	8	116

spondents were in agreement that bringing creationism into the classroom means bringing religion into the classroom as well (Table 2). The responses to this question were not independent of the type of school in which the instructor taught (X^2-test, $P < 0.02$). Teachers in public and private nonsectarian schools were significantly more likely to agree with this statement than those working in private sectarian institutions. Responses to this question were independent (X^2-test, $P > 0.10$) of the responses to question 2 (*Do you teach evolution?*), although 1.35 times as many people teaching evolution agreed with the statement as those not teaching the subject (Table 4). The situation was quite different with respect to question 3 (*Do you teach creationism?*). Responses to question 3 were not independent (X^2-test, $P < 0.001$) of feelings concerning the religious nature of creationism. Of those teaching creationism, 20.7% felt that doing so meant bringing religion into the classroom, whereas 61.4% of those not teaching creationism held that view.

ACCEPTANCE OF THE MODERN THEORY OF EVOLUTION. A large majority of the teachers indicated that both they (78.2%) and scientists (90.1%) accepted the modern theory of evolution (Table 2). The beliefs of individuals varied significantly (X^2-test, $P < 0.05$) with respect to the school in which they worked. Instructors in private sectarian schools were least likely to accept the theory. Teachers' opinions about the beliefs of scientists, however, were independent (X^2-test, $P > 0.20$) of institutional type. An individual's acceptance of evolutionary theory and that person's perception of the acceptance of the theory by scientists were not independent (X^2-test, $P < 0.001$) of one another. Teachers that accepted evolutionary theory were much more likely to believe that scientists also accepted the theory. Those not accepting it were significantly less likely to feel that way.

Course content was not independent of the individual's personal feelings about evolutionary theory (Table 4). Individuals teaching evolution were significantly (X^2-test, $P < 0.01$) more likely to accept evolutionary theory than those not teaching the subject. Individuals offering creationism were significantly (X^2-test, $P < 0.001$) less likely to accept the theory than colleagues omitting the subject. The relationship between course content and teachers' opinions about the acceptance of evolutionary theory by scientists was less straightforward (Table 4). Although those teachers that included an evolutionary component in their courses were significantly (X^2-test, $P < 0.001$) more likely to think that scientists accepted evolutionary theory than teachers not offering evolution, no such relationship (X^2-test, $P > 0.10$) was found when the inclusion of creationism in the curriculum was examined.

UNDERSTANDING EVOLUTIONARY THEORY. Question 12 allowed teachers to indicate which phrase best described the modern theory of evolution. The correct answer is the one describing differential reproductive rates (B). As Fuerst (1984) noted, the remaining options differ to varying degrees from the correct description. Answers A and E both deal with survival, and thus are related to the concept of differential reproduction. Answers C and D cannot be considered as accurate descriptions of modern evolutionary theory.

The most common description of evolution selected was the phrase, "survival of the fittest", which was chosen by 41.3% of the respondents (Table 7). Almost one-fourth (22.3%) of the teachers thought that evolution involved a purposeful striving towards "higher" life forms. Fewer instructors selected the correct answer (11.6%) than indicated that they were unsure (15.1%). A majority of teachers (61.4%) chose some combination of the three natural selection answers.

The primary responses (A-E) were grouped in order to achieve large enough sample sizes for meaningful statistical analyses. Three groups were formed: the two incorrect natural selection answers (A, E); the two totally inappropriate responses (C, D); and the correct reply (B). Because of the small number of respondents from private nonsectarian schools, the existence of differences across the three types of institutions could not be determined. Responses from public and private sectarian schools, however, did not differ (X^2-test, $P > 0.50$) from one another. There were no significant (X^2-test, $P > 0.10$) differences in the descriptions of evolution chosen by those instructors teaching evolution and those not offering a section on evolution (Table 7). Similarly, there were no differences (X^2-test, $P > 0.10$) between those people satisfied with the coverage of evolution in their textbooks and those dissatisfied (Table 7). There was, however, a difference (X^2-test, $P < 0.02$) between those teaching creationism and those omitting the subject (Table 7). Significantly more teachers (65.4%) offering courses without creationism selected either the correct response or one of the natural selection answers than did those (46.7%) teaching creationism.

SCIENTIFIC BASIS OF EVOLUTION AND CREATIONISM. Over three-fourths (77.0%) of the teachers indicated that the modern theory of evolution has a valid scientific foundation (Table 8). Conversely, only 17.1% of the respondents felt that creationism had a valid scientific foundation (Table 8). When the two "yes" responses were grouped together and the three "no" responses pooled, there were no significant (X^2-tests: evolution, $P > 0.10$; creationism, $P > 0.05$) differences in the responses to either question offered by teachers working in the three types of schools. Perceptions of the two topics, however, were not independent of one another (X^2-test, $P < 0.001$). Whereas 63.6% of the teachers said that evolution was scientific and creationism was not, 6.4% indicated that creationism, but not evolution, was scientific. Approximately 10% and 8% of the teachers, respectively, felt either that both concepts were scientific or that neither was.

The responses to these two questions as a function of the answers to three other questions are presented in Table 8. The teaching of evolution was independent (X^2-test, $P > 0.05$) of the perception of the scientific basis of evolutionary theory. Both the teaching of creationism and a belief in the modern theory of evolution were not independent (X^2-tests, $P < 0.001$) of the acceptance of the scientific validity of evolution. In both cases, instructors that did not teach creationism and those that believed in evolutionary theory were significantly more likely to say that evolution has a valid scientific foundation.

The teaching of evolution, the teaching of creationism, and the acceptance of evolutionary theory were

TABLE 7

Percentages of answers (N = 404) to question 12 (Which of the following best agrees with your impression of the modern theory of evolution?) as a function of the response to questions 2 (Do you teach evolution?), 3 (Do you teach creationism?), 4A (Are you satisfied with the coverage of evolution in your text?), and 10 (Do you believe in the modern theory of evolution?). All respondents omitting the question or selecting a combination of answers not listed below were classified as unsure. The natural selection totals exceed the sums of responses A, B, and E because some respondents selected more than one answer. Answers C, D, Unsure, and Natural Selection sum to 100%.

	Answer to question 2		Answer to question 3		Answer to question 4A		Answer to question 10		
Response to question 12	Yes	No	Yes	No	Yes	No	Yes	No	Total
Survival of fittest (answer A)	41.5	36.6	30.4	44.2	42.1	35.0	44.0	32.2	41.3
Different no. of offspring (answer B)	12.6	4.9	7.6	12.9	11.2	18.3	13.3	6.8	11.6
Strong eliminate weak (answer E)	1.7	2.4	1.1	2.0	2.2	0.0	1.9	1.7	1.7
Natural Selection (any combination of A, B and E)	63.0	46.3	46.7	65.4	62.3	60.0	66.5	44.1	61.4
Evolution from gorilla (answer C)	1.4	0.0	3.3	0.7	1.2	0.0	0.6	3.4	1.2
Purposeful striving (answer D)	21.3	34.2	28.3	20.8	22.4	20.0	19.0	33.9	22.3
Unsure	14.3	19.5	21.7	13.2	14.0	20.0	13.9	18.6	15.1

TABLE 8

Percentages of responses (N = 404) to questions 13 (Does the modern theory of evolution have a valid scientific foundation?) and 14 (Does creationism have a valid scientific foundation?), as a function of the responses to questions 2 (Do you teach evolution?), 3 (Do you teach creationism?), and 10 (Do you believe in the modern theory of evolution?). Total Yes and No values include those individuals giving multiple responses. Total Yes, No, and Unsure responses sum to 100%.

	Answer to question 2		Answer to question 3		Answer to question 10		
Responses	Yes	No	Yes	No	Yes	No	Total
Evolution:							
Yes, because testable (A)	56.3	36.6	37.0	60.1	65.8	3.4	54.0
Yes, but not testable (B)	19.3	29.3	17.4	20.8	22.8	13.6	20.5
No, because not testable (C)	2.0	4.9	4.4	1.6	0.6	8.5	2.2
No, based on speculation (D)	7.3	12.2	15.2	5.3	0.3	42.4	7.7
No, other reasons (E)	4.2	4.9	8.3	3.6	1.3	17.0	4.5
Total Yes (A and/or B)	78.4	65.9	58.7	82.8	91.5	17.0	77.0
Total No (C, D and/or E)	14.8	26.8	32.6	11.2	2.2	78.0	16.1
Unsure	6.7	7.3	8.7	5.9	6.3	5.1	6.9
Creationism:							
Yes, because testable (A)	4.8	9.8	13.0	3.0	2.2	15.3	5.2
Yes, but not testable (B)	10.4	22.0	17.4	9.2	7.9	33.9	11.6
No, because not testable (C)	1.7	7.3	3.3	2.0	1.3	3.4	2.2
No, based on speculation (D)	43.7	34.1	28.3	47.9	49.7	16.9	42.6
No, other reasons (E)	28.9	9.8	22.8	28.7	30.1	11.9	27.0
Total Yes (A and/or B)	15.5	31.8	31.5	12.2	10.1	50.8	17.1
Total No (C, D and/or E)	75.6	56.1	56.5	80.2	82.6	33.9	73.5
Unsure	9.0	12.2	12.0	7.6	7.3	15.3	9.4

not independent (X^2-tests, $P < 0.02$, $P < 0.001$, $P < 0.001$, respectively) of the feelings held by teachers concerning the scientific basis of creationism. One-half (50.8%) of the teachers professing a disbelief in evolutionary theory, for example, indicated that creationism was solid science, whereas only 10% of those accepting evolutionary theory felt similarly.

SHOULD CREATIONISM BE TAUGHT IN THE PUBLIC SCHOOLS? Over one-third (37.6%) of the respondents indicated that creationism should be taught in the public schools (Table 2). Instructors in private sectarian schools were significantly (X^2-test, $P < 0.001$) more likely to hold this opinion than teachers in either public or private nonsectarian institutions. Of the 152 teachers recommending that creationism be introduced into the public school curriculm, 101 stated that the introduction should take place in a science class. Twenty-seven respondents mentioned courses of study other than science (e.g. social studies, philosophy, humanities, history, religion, and the like), whereas 24 stated no particular preference. Thus, 25% of all respondents stated explicitly that creationism should be introduced into the science curriculum of public schools.

Whether instructors teach evolution was independent (X^2-test, $P > 0.50$) of their feelings about the inclusion of creationism in the public schools (Table 4). Whether creationism was offered, however, was significantly (X^2-test, $P < 0.0001$) associated with teachers' opinions about the acceptability of teaching creationism in public institutions (Table 4). Similar results were found when the analysis was repeated including only teachers working in public schools (X^2-test, $P < 0.0001$). Surprisingly, this analysis also demonstrated that 18 public school teachers are currently teaching creationism, although they do not feel that the subject belongs in public schools. An additional 72 public school teachers offer no instruction in cre-

ationism, but think that such instruction properly belongs in public schools. Thirty-seven in the latter group indicated that it belongs in the science classroom.

Teachers' opinions about whether creationism belongs in the public schools were also significantly (X^2-tests, $P < 0.001$) associated with responses to three other questions: question 9 (*Does bringing creationism into the classroom mean bringing religion into the classroom?*); question 10 (*Do you believe in the modern theory of evolution?*); and question 11 (*Do you think that most scientists believe that the modern theory of evolution is a valid scientific theory?*) Positive responses to each of these questions were significantly associated with the opinion that creationism does not belong in the public schools. Teachers that believed that creationism should be introduced into the public schools were also significantly (X^2-test, $P < 0.001$) more likely to believe that creationism has a solid scientific foundation than would be expected by chance alone.

RELIGION AND PRAYER IN THE PUBLIC SCHOOL. Although over one-half (59.4%) of the respondents objected to the introduction of religion into the public schools, only 37.4% claimed to object to prayer in the public schools (Table 2). The responses to these two questions were not independent (X^2-test, $P < 0.001$) of one another. Of the 379 instructors who offered an opinion on both of these two questions, 96 found prayer acceptable, but objected to religion in the public schools. Responses to both questions varied across the three types of institutions (X^2-tests: religion, $P < 0.001$; prayer, $P < 0.02$); in both cases significantly fewer teachers from private sectarian schools objected than were expected by chance alone.

Responses to the questions dealing with religion and prayer in public schools were independent of whether teachers included evolution in their courses (X^2-tests, $P > 0.30$) (Table 4). Responses to these two questions, however, were not independent (X^2-tests: religion, $P < 0.001$; prayer, $P < 0.01$) of whether creationism was taught. Individuals teaching creationism were significantly less likely to object to either religion or prayer in the public schools than teachers omitting the subject. Interestingly, there were 10 public school teachers who objected to the teaching of religion in the public schools; felt that bringing creationism into the classroom means bringing religion into the classroom as well; and taught creationism in their biology course. Of these, one clearly discussed creationism in a negative light, and seven appear to do so in a favorable context. The remaining two teachers did not offer comments that enabled a determination of the specific nature of their coverage of creationism.

COMPARISONS WITH OTHER SURVEYS. Identical questionnaires were distributed by Fuerst (1984) to Ohio State University (OSU) students and by Zimmerman (1986) to Oberlin College (OC) students. Six of the items on those questionnaires were virtually identical to questions on the present questionnaire. Additionally, three of the questions were originally posed by *Glamour* magazine (August, 1982).

Does the introduction of creationism into the public schools mean the introduction of religion as well? Ohio high school biology teachers' opinions about this matter were intermediate between OC students and OSU students. Approximately 52% of the teachers felt this way, whereas 60% of OC undergraduates and 42% of the OSU group felt similarly. People in all three studies who expressed a belief in the modern theory of evolution were significantly (X^2-tests, $P < 0.0001$) more likely to agree that creationism has a religious component. The total percent (78.2) of Ohio teachers claiming to believe in the modern theory of evolution was not as high, however, as was the percent (89.2) of the OC students holding this belief. It was appreciably higher, however, than the percentages from both the OSU survey (63%) and the *Glamour* poll (47%). Ninety percent of teachers and OC students felt that scientists accept the modern theory of evolution, whereas only 75% of the OSU students did so.

More teachers (11.6%) than either OSU students (8%) or OC students (6.7%) recognized that the best definition of evolution offered centered on differential reproduction. Teachers (61.4%) were not quite as likely to select one of the natural selection answers as were OC students (67.9%), although they did so considerably more often than the OSU students (48%). In all three surveys, the most common response was the phrase "survival of the fittest", followed by the thought that evolution involved some sort of purposeful striving towards higher life forms. Teachers were not quite as likely to accept that evolution has a solid scientific foundation as were OC students (77% vs. 87.6%, respectively), but were much more likely to do so than students enrolled at OSU (59%). Similar percentages of teachers and OC students (91.5% vs. 90%, respectively) who believed in evolutionary theory also agreed that it has a scientific basis, although a striking difference existed between teachers and OC students who did not accept evolutionary theory. Whereas 55.6% of the OC students not accepting evolutionary theory felt that evolutionary theory was solidly scientific, only 17% of the teachers not accepting evolutionary theory held that view.

Responses to the question asking whether creationism should be taught in the public schools varied markedly across the four groups polled. Fewer Ohio teachers (37.6%) felt that creationism belongs in the public schools than respondents in the other samples (56.3% of OC students, 74% of the *Glamour* respondents, and 80% of the OSU respondents felt that it should be included). Public school teachers in Ohio were even more extreme. Only 34.3% in public schools preferred that creationism be taught. The responses of teachers (51.7%) in private sectarian schools, however, were quite similar to the OC student responses. The teachers who believed in evolutionary theory were much less likely to want creationism in the public schools (28.8%) than the students believing in evolution at either OC (52.6%) or OSU (74%). Doubters of evolutionary theory in each of the three groups were more likely to want creationism taught in the public schools. The percentages of doubters feeling this way were quite similar (OSU students, 91%; OC students, 85.7%; Ohio teachers, 83.1%).

DISCUSSION

The most striking result of this study is that such a small percentage (37.6%) of the total respondents favored the introduction of creationism into the public schools. Of those teachers working in private sectarian

high schools, only slightly more than one-half favored a two-model approach to the teaching of evolution. In contrast, all polls of the general population have indicated that between 74 and 94% of those questioned prefer that creationism be introduced into the public schools. Even a majority of the students at Oberlin College, who tend to be more liberal than the population at large, favored such an introduction (Zimmerman 1986). Although Fuerst (1984) found a significant relationship between the amount of biological education received and favorable feelings towards evolutionary theory, well over one-half of the biology graduate students that he surveyed indicated their preference for creationism in the public schools. Since biology graduate students would, in general, have taken more biology classes than the average high school biology teacher, it is unlikely that the amount of formal coursework in biology experienced by teachers is sufficient to explain their feelings on this issue. What does seem clear is that many teachers have not accepted the creationist argument that omitting creationism from the public school classroom is an infringement of both free speech and academic freedom (Morris 1974, Morris and Rohrer 1982). This is the argument that creationists have largely decided to stress (Edwords 1980, Lewin 1981, Nelkin 1982), and that seems particularly compelling to academics and/or individuals holding liberal views (Zimmerman, 1986). Why has this approach not been successful with teachers? A possible explanation is that teachers might be more scientifically literate than the public at large. Koshland (1985), for example, noted that the general public has a poor understanding of how scientists work. Creationists encourage such ignorance (Edwords 1980) by rarely stating the basic tenets of creationism and instead attempting simply to attack evolution. Since only 17% of the teachers surveyed stated that creationism has a solid scientific foundation, it is not surprising that such a large percentage did not want "nonscience" taught alongside biology.

A common criticism of creationism in the questionnaires was that creationism was based on faith and thus was outside the realm of science. High school biology teachers might well have had a greater opportunity to encounter "creation science" literature than members of any other group surveyed. When scientific respectability is stripped away from creationism, it becomes more difficult to defend as an honest intellectual pursuit. The free speech/academic freedom argument is not compelling when the topic under discussion has no academic merit on which to stand. As more people become aware that "scientific creationism" is nothing more than biblical literalism in disguise, and as it becomes clear that creationists strive vehemently to hide that fact, the arguments offered for incorporating the subject into the public school curriculum will be more difficult to defend. Indeed, although the acceptance of "creation science" by the general public is quite high, a much smaller percentage of people respond favorably to specific creationist arguments. In a study of undergraduate students at Central Connecticut State University, Feder (1984) found that only 30 to 40% of the respondents reacted favorably to the following statements: Every word in the Bible is true; The flood of Noah as told in the Bible really happened; and Adam and Eve were the first human beings. Feder also found that only 20% of the students sampled agreed that God created the universe in six, 24-hour days. A follow-up study (Eve and Harrold 1986) of student views at The University of Texas at Arlington reported similar but slightly more extreme views. As predicted, students from the Southwest were more likely to agree with creationist arguments than students from the Northeast.

It is clear that practicing high school biology teachers in Ohio, relative to other groups surveyed, hold extreme views on the subject of interjecting creationism into the public schools. Even so, it is noteworthy that at least 25% of the teachers surveyed felt that creationism belonged in the public schools as part of the science curriculum and that at least 15% of the teachers surveyed are currently teaching creationism in a favorable light. Interestingly, only 3.3% of those instructors teaching creationism have received any pressure to stop this practice. Even among the public school teachers offering creationism, only 4.9% have been pressured not to do so. Because the evolution/creation debate is clearly within the public sector, it is imperative for those people on the evolution side of the issue to become as active as are the creationists, if quality science education is to be offered uniformly in our high schools. The data from the present study indicate that creationists have been much more active than evolutionists in promoting their cause to teachers. For example, pressure to teach creationism on those not already teaching creationism was 4.5 times greater than pressure to teach evolution on those not already teaching evolution. Similarly, 10.6% of the teachers offering evolution have received some pressure to remove it from their courses, whereas, as mentioned above, only 3.3% of those offering creationism have been pressured to remove it from the classroom. Furthermore, the sources of the pro-evolution and pro-creationism pressures are quite different (Table 6). Of the 79 instances in which pro-creationism pressure was perceived (i.e. pressure to omit evolution or to teach creationism), 82.3% came from sources outside the school bureaucracy (e.g. parents, church figures, students) rather than from the school administration, colleagues, curriculum, or textbook. Only 7.4% of the pro-evolution pressure, on the other hand, came from outside the school's administrative structure.

Some evolutionary theory is being presented in a large percentage (87.7%) of the biology courses taught in Ohio in 1986. This percentage compares favorably with a much smaller survey conducted in Essex County, New Jersey in 1950 (Laba and Gross 1950) in which 72.4% of the teachers indicated that they taught evolution. A nationwide survey published in 1942 (Riddle 1942), however, indicated that 95.4% of high school teachers covered evolution to some degree. The New Jersey study found that on average six class periods were spent on evolution; the Newark curriculum guide recommended 10. Current Ohio teachers offering the subject average 7.5 class periods, which is still considerably lower than the number recommended for Newark public schools 36 years ago. If only those courses in which more than five class periods are devoted to evolution are considered to be stressing evolution, the percentage of courses offering evolution drops to 45%. Only 24% of the courses surveyed offered at least 10 class periods on evolution.

Given these numbers, those in favor of evolution should not feel particularly complacent about the fact that some evolution is being taught in 87.7% of the high school biology courses offered in Ohio (although there were a few teachers who said that they treat evolution as a theme running throughout the entire course).

There are at least two additional reasons why the situation in Ohio is far from ideal. First, and most apparent, is the fact that 12.3% of the Ohio high school students taking biology are apparently receiving no formal instruction in evolutionary theory. Given the importance that evolution has to all of modern biology as an organizing principle (Dobzhansky 1973), it is difficult to imagine what sort of science these students are actually being taught in high school. It seems exceedingly unlikely that many high school biology courses could focus on such specialized topics that there is no place for a section on evolution. Indeed, only one of the 472 courses had a title (anatomy/physiology) remotely indicating such a possibility. Second, the frequency with which the correct description of the modern theory of evolution was chosen was distressingly low. It is true, as a number of respondents pointed out, that none of the choices offered are perfect, and that it is hard to summarize an entire theory in a single phrase. Nonetheless, some of the responses are clearly incorrect; others are simply not very illustrative. The most commonly selected response (survival of the fittest) is a phrase that is often associated with Darwinism, but that really offers very little information about the evolutionary process. A much greater cause for concern is the fact that over 20% of the individuals teaching evolution indicated that the modern theory of evolution was best described as a purposeful striving towards higher life forms.

At a time when most high school biology textbooks are under attack for not including much, if any, coverage of evolution (Skoog 1979, Moyer and Mayer 1985), it was somewhat surprising that over three-fourths (78.2%) of the teachers expressing an opinion indicated satisfaction with the coverage of evolution in their textbooks. Indeed, all of the junior high school biology textbooks submitted for approval to the California State Board of Education in September, 1985 were rejected because of a lack of sufficient coverage of evolution (Marshall 1985).

Interestingly, the Biological Sciences Curriculum Study (BSCS) textbooks, originally designed with financial support from the National Science Foundation to stress evolutionary concepts, fared much better than other books in the present study. Of the 45 teachers using one of the three BSCS textbooks, only three were not satisfied with their textbook's coverage of evolution. Sixty of the 262 teachers using other books found the coverage of evolution to be unsatisfactory. The BSCS books were not heavily used, however; only 14% of the courses for which a textbook was indicated used these textbooks. At the other extreme, at least 12 courses used textbooks with a distinct bias in favor of creationism (e.g. *Biology for Christian Schools,* Bob Jones University Press; *Biology: A Search for Order in Complexity,* Zondervan Publishing House). All were used in private schools, and the evolution and creation components of each were found satisfactory by teachers.

It is possible that if the recent decisions by the bodies responsible for adopting textbooks for California, Texas and New York City schools (Lewin 1984, Marshall 1985) encourage publishers to include once again more detailed coverage of evolutionary matters in their books, then teachers may devote more time to the subject in the classroom. Additionally, teachers exposed to these improved textbooks may achieve a better understanding of the rudiments of evolutionary theory. Many teachers follow their textbooks and curriculum guides fairly rigorously. In fact, 72 public school teachers indicated that they felt that creationism belonged in the public schools, but that they themselves were not teaching it. The simplest explanation of this paradox may be the absence of creationism from any curriculum in Ohio and its limited coverage, if any, in most textbooks. As things currently stand, many textbooks include coverage of evolution in the final chapter. If publishers are encouraged to integrate evolutionary concepts throughout textbooks, it seems reasonable to expect that the quality of classroom instruction in the subject will increase as well.

The present study demonstrated a link between teachers' willingness to accept religion and/or prayer in the public schools and the willingness to teach creationism there. However, less than one-third (31.5%) of the instructors teaching creationism felt that it has a solid scientific foundation, and only 13% felt that it was testable. These results suggest that the pro-evolutionary forces, when dealing with these teachers, might work toward limiting the amount of creationism introduced into the public schools by not battling creationists directly, but rather by stressing the importance of the separation of church and state. This will not be easy to do, however, since 64% of the teachers offering creationism do not object to religion in the public schools.

There also remains the fact that teachers and the public alike must learn how to distinguish science from religion. Although numerous definitions of science have been advanced over the years (Popper 1959, Nagel 1961, Kuhn 1962, Hempel 1966), the one accepted by Judge W. Overton in his 1982 decision in the McLean vs. Arkansas Board of Education Equal Time Case was offered by Ruse (1983) in court and in print. It consists of five straightforward points: Science 1) is guided by natural law; 2) has to be explanatory by reference to natural law; 3) is testable against the empirical world; 4) is tentative (i.e. its conclusions are subject to change); and 5) is falsifiable. Statements and responses to questions in the present survey indicated that many teachers have no trouble recognizing that creationism does not adequately fit the definition of a science. However, the perceptions of evolution are not quite that clear. Only slightly over one-half (54%) of the respondents, for example, indicated that evolutionary theory was testable. Even among those teaching evolution, 15% stated explicitly that evolution was not scientific. Science as process, as a method of better understanding the world, is not adequately appreciated. Instead science is viewed as a compilation of "facts". The concept of a dichotomous choice between evolutionary theory and "creation science", as proposed by creationists in their two-model approach (Morris 1974), is antithetical to the tenets of science outlined by virtually all philosophers of science. The public must be made aware that the creationist tactics of attacking evolutionary ideas, and of exaggerating and misrepresenting any disagreements among proponents of evolution, does

not in any way substitute for a lack of scientific substance within creationism. When an intensive study of the editors of scientific journals turns up virtually no "creation science" articles (18 of 135,000) submitted during a 3-year period (Scott and Cole 1985), there should be no doubt that creationism is lacking scientific substance.

CONCLUSION

Although it does not make educational sense for the science curricula of our schools to be determined by popular opinion, this appears to be the trend. The present study has demonstrated that the pro-creationism forces are currently much more active in exerting pressure on high school biology teachers than are the pro-evolutionary forces. If the battle, at least in part, is to be waged in this manner, then it is critical for the proponents of evolutionary theory to become more vocal and more involved in educational policy. The results of this study suggest that high school teachers will probably be fairly receptive to this approach, and that they might well be strong allies in a push to educate not only students, but parents as well, about the importance of evolutionary theory.

The present study reports the outline and not the full substance of what is currently going on in high schools throughout Ohio with respect to the evolution-creation controversy. As such, it is the first step toward learning what teachers are actually teaching their students. It is surprising, for example, that even in the absence of any laws mandating the teaching of creationism, 15% of the high school biology courses in the state present creationism favorably. This study, at least, defines the parameters of the problem and will open opportunities for future, more detailed research.

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APPENDIX Questionnaire sent to 1,013 high schools in Ohio on 1 February 1986.

1. What grade level of biology do you teach?
2. Is there a section on evolution in your biology course? Yes; No. If yes, how many class periods or portions thereof?
3. Is there a section on creationism in your biology course? Yes; No. If yes, how many class periods or portions thereof?
4. What biology textbook do you use?
   A. Are you satisfied with its coverage of evolution? Yes; No. Comments:
   B. Are you satisfied with its coverage of creationism? Yes; No. Comments:
5. Has any pressure ever been applied to you not to teach evolution? Yes; No. By whom?
6. Has any pressure ever been applied to you to teach evolution? Yes; No. By whom?
7. Has any pressure ever been applied to you to teach creationism? Yes; No. By whom?
8. Has any pressure ever been applied to you not to teach creationism? Yes; No. By whom?
9. Do you agree with the people who claim that bringing creationism into the classroom means bringing religion into the classroom? Yes; No.
10. Do you believe in the modern theory of evolution? Yes; No.
11. Do you feel that most scientists believe that the modern theory of evolution is a valid scientific theory? Yes; No.
12. Which of the following best agrees with your impression of the modern theory of evolution?
   A. The phrase "Survival of the Fittest"
   B. Evolution occurred because different individuals left different numbers of offspring
   C. Man evolved from either the gorilla or chimpanzee in Africa
   D. Evolution involved a purposeful striving towards "higher" forms (that is a steady progress from microbes to man)
   E. Evolution occurred because the strong eventually eliminated the weak
13. Do you think that the modern theory of evolution has a valid scientific foundation?
   A. Yes, because it is possible to test many predictions of evolutionary science
   B. Yes, even though we can never test predictions about events in the past
   C. No, because we can never be sure about the past
   D. No, because evolutionary science is principally based on speculation, and not on "hard" scientific fact
   E. No (for other reasons)
14. Do you think that creationism has a valid scientific foundation?
   A. Yes, because it is possible to test many predictions of creationism
   B. Yes, even though we can never test predictions about events in the past
   C. No, because we can never be sure about the past
   D. No, because creationism is principally based on speculation, and not on "hard" scientific fact
   E. No (for other reasons)
15. Do you believe that creationism should be taught in the public schools? Yes; No. If Yes, in what subject?
16. Aside from comparative religion and allied subjects, do you object to the introduction of religion into the public schools? Yes; No.
17. Do you object to prayer in the public schools? Yes; No.
18. In what sort of high school do you teach?
   A. Public
   B. Private Sectarian
   C. Private non-sectarian
19. Additional comments

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